

MAGNETORESISTIVE READOUT FOR DOMAIN ADDRESSING INTERROGATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to digital data processing, storing and signal translating devices utilizing cylindrical magnetic domains (commonly called magnetic bubbles) in a uniaxially anisotropic magnetic medium such as a single crystal platelet. Such devices are particularly useful in providing an orthogonal or random access high speed non-destructive readout memory. They may also be used for comparators and for many other logic configurations. The present invention relates particularly to the use of a juxtaposed pair of such platelets co-acting with an interposed magnetoresistive element to provide a nondestructive readout in a device occupying a minimum volume and having maximum detection sensitivity.

2. Prior Art

In my copending patent application Ser. No. 205,095, filed Dec. 6, 1971, entitled "Magneto-Optical Devices" I have disclosed an analogous class of logic and memory devices also using magnetic bubbles or single wall domains in various plane magnetic media but relying primarily on optical readout techniques rather than the magnetoresistive technique disclosed herein. Specifically different devices of primarily a serial shift register nature but which also use such magnetic domains, have also been described in an article which appeared in the June 1971 issue of the magazine "Scientific American" written by A. H. Bobeck and H.E.D. Scovil and entitled "Magnetic Bubbles." U.S. Pat. No. 3,513,452 issued to Brobeck et al, on May 19, 1970 does relate to an orthogonal array rather than a serial shift register, but it discloses only such an array in a single platelet utilizing inductive readout techniques which are inherently less sensitive, require a larger number of access and drive conductors, and hence provide less storage capacity in terms of bits per unit volume.

A combined packaging, magnetic biasing, and electrical connector structure is disclosed and claimed in my patent application entitled "Packaging Structure for Movable Magnetic Domain Devices" which is being filed concurrently herewith and which discloses and claims a packaging-biasing-connector structure suitable for use with any of the devices discussed herein or in the prior art noted above.

SUMMARY OF THE INVENTION

The present invention relates to a magnetoresistive readout arrangement for such two platelet magnetic bubble devices which utilizes the combined magnetic field producing qualities of correspondingly positioned bubbles in each of two magnetically coupled magnetic media to produce field pattern changes which afford a sensitive and high signal to noise readout signal in devices such as a mass memory. The locally controlled motion between two contiguous alternate bit positions of a cylindrical magnetic domain in one magnetic crystal platelet is used to produce in a magnetoresistive sensor element a signal the nature of which depends upon the presence or absence in a predetermined corresponding position of a cylindrical domain in another adjacent similar platelet. The first platelet is provided

with an orthogonal conductor array to control domain position at each intersection and serves as a memory. The second platelet is provided with a similar conductor array and serves as the interrogator. Each magnetic domain supporting crystal is a uniaxial anisotropic ferromagnetic crystal platelet, such as yttrium orthoferrite, having its major plane surface cut perpendicularly to its easy axis of magnetization.

The magnetoresistive readout arrangement of this invention is particularly suited to the detection of a large number of domains on a large number of such platelets simultaneously. In such applications optical readouts can become quite bulky and inductive loops must be large to provide the necessary sensitivity. Inductive loops are also limited to the dynamic detection of change of flux and are unable to sense the presence or absence of a stationary domain. The magnetoresistive sensor disclosed herein in which the resistance of a thin film is changed by the proximity of two domains, combines the feature of simplicity and small size in a mass memory having high speed random access nondestructive readout with high signal to noise ratio output which is available as either a steady state or d.c. signal and/or as a dynamic or a.c. signal.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood from the detailed description below taken in conjunction with the drawings wherein like reference characters refer to like parts throughout and in which:

FIG. 1 is a fragmentary sectional view through a crystal platelet showing a magnetic bubble therein and indicating the relationship of the lines of flux of the magnetic field of the bubble to a magnetoresistive sensor positioned adjacent to the platelet.

FIGS. 2a, 2b and 2c (sheet 4) are diagrammatic views illustrating three possible vector relationships between a magnetic field H and the current I flowing in a thin film magnetoresistive conductor.

FIG. 3a is a fragmentary sectional view through similar crystal platelet similar to that of FIG. 1 but showing the effect on the magnetic field of the bubble when a second crystal platelet without a correspondingly positioned bubble is positioned adjacent to the first.

FIG. 3b is a view similar to FIG. 3a but wherein the second platelet does have a correspondingly positioned magnetic bubble adjacent to the magnetic bubble in the first platelet.

FIG. 4 is an exploded perspective view of two crystal platelets and three glass plates having conductor arrays thereon such that when assembled the entire device will function as a high speed random access non-destructive readout memory.

FIG. 5 is an exploded perspective view showing the manner in which the plates and platelets of FIG. 4 are assembled in a biasing magnet and packaging structure.

FIG. 6 is an assembled perspective view of the components of FIG. 5.

Turning now to FIG. 1, it will be seen that the magnetic field 23 of a cylindrical domain 21 in a magnetic domain supporting crystal platelet 22 (which may, for example, be an yttrium orthoferrite crystal cut as disclosed in my copending application Ser. No. 205,095) extends into the space above and below the platelet as indicated by the flux lines of field 23. A thin film magnetoresistive sensor 24 which is sensitive to in-plane